

Different worlds: Looking deeply at context in the sustainability of PD for collaborative problem-solving mathematics

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In this paper, I look at multiple layers of context to explore the *figured world* of mathematics teaching in primary schools in Chile. I collected data from 15 teachers during 18 months after their participation in professional development for collaborative problem-solving mathematics. I found constraints to impact on the teachers' implementation of new pedagogy at personal, local, institutional, national, and global levels. Whilst these constraints acted directly to constrain practice, they also acted to produce the imagined realities for teachers of mathematics in their particular world.

As I approached the school, I saw immaculately dressed children dropped off by their parents and greeted by staff with a kiss. The security guard let me in through the imposing gates and I entered a concrete building that surrounded a very small courtyard. Children of all year levels were playing in this small space and I could see no grass anywhere. It was dark and freezing. Entering the classroom, I saw paint peeling from concrete walls and long rows of desks. Soon 45 year-one students took their places, quietly sitting and attending to their teacher. They were extremely well behaved and appeared happy to chant and skip count and later to choral their answers to a mathematics exercise in unison. I was definitely in another country, was I in another time?

Research reports typically include a section titled "context" in which the local and institutional contexts are briefly described. Such brevity does not do justice to the hugely complex and multi-layered aspect of the worlds in which we teach and learn mathematics. Most often, MERGA participants come from educational contexts that are resource-rich and may have considerably less experience in schools that appear on first glance deprived and that display many other cultural differences embedded in day-to-day practices.

My experiences living, working and researching in a context very unlike my own motivated this paper. In 2015, I left New Zealand to take up a post-doc in Santiago, Chile and soon after, I began a research project looking at teachers' identities and experiences after their participation in a programme of professional development (PD) in collaborative, problem-solving mathematics. On my first visit to a mathematics classroom in a mid-low income area of Santiago, I was struck by the vast differences between this world and my own memories of teaching primary school in New Zealand. These differences were evident in both the environment and the typical teaching-learning contract. It soon became apparent to me that the changes expected of teachers through the PD were far greater than I had assumed they would be when I designed my research. This had implications for data collection and analysis of my own project, as well as the overall success and sustainability of the PD programme. Only by close attention to context would I be able to make sense of my findings.

In this paper, I wish to explore context deeply. I will use Holland and colleagues' concept of figured worlds (Holland, Skinner, Lachicotte, & Cain, 1998) to describe and analyse primary mathematics teaching in Chile through the various layers of context – from the

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personal and local layer of classroom and community through to institutional, national and global contexts. This world I will compare and contrast with the figured worlds of: mathematics teaching in New Zealand, and of reform-oriented discourse. My aim is to answer the question: *How do the various layers of context influence success and sustainability in PD for collaborative problem solving in mathematics?*

Theoretical Framework

I draw upon Holland and colleagues' (1998) concept of figured worlds. A figured world is "a social and culturally constructed realm of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others" (p. 52). In this case, the figured world at play is the world of teaching mathematics at the primary school level in Chile. The key 'characters' in this figured world are teachers and students, but also school principals, colleagues, parents and caregivers. The most relevant 'act' to this research project is the teaching and learning of mathematics, and the interpretations of this act as developed historically, socially organized and reproduced by stylized interactions between teachers and learners.

Wider political and social contexts, and the more local and personal contexts, are instrumental in the formation and structuring of the storylines within a figured world. Firstly, storylines are a central narrative or a taken-for-granted unfolding of particular activities, such as teaching. Secondly, in the world of learning or teaching mathematics, context may refer to the political context of education policy, the social world of class systems, racial and gender relations, and local contexts of individual schools and school networks. The specific context helps generate the storylines drawn upon in people's understandings and constructions of their figured world. The typical storylines created by actors in the world are key to analysis; they tell us much about the figured world and provide a "backdrop for interpretation" (Holland et al. 1998, p. 54) of performances and activities; the meanings of everyday events are figured against these storylines.

The Situated Nature of PD

Within the broader literature on PD there is certainly attention paid to context or the "situated nature" of PD (Avalos, 2011). Teacher PD is a complex process, thus there is a need to examine "the interacting links and influences of the history and traditions of groups of teachers, the educational needs of their student populations, the expectations of their educational systems, teachers' working conditions and [their] opportunities to learn" (Avalos, 2011, p. 10). Within mathematics education, research on PD is a growing field (Skott, van Zoest, & Gellert, 2013; Sztajn, Borko, & Smith, 2017), yet in a recent review of PD research in the NCTM compendium, little attention is paid to issues of context, rather focus is on impact, sustainability and PD comparisons (Sztajn et al., 2017).

Some authors within our discipline have found context to be an important factor in success and sustainability of PD programmes. Gresalfi and Cobb (2011) examine both the institutional context and the context for PD to understand the distinct identities that teachers construct through their participation. They argue that these identities, formed in context, are central for teachers becoming motivated to improve their classroom practice. Similarly, Battey and Franke (2008) used the notion of identity and examined how teachers participated in both the settings of PD and the classroom in order to understand the relationships between these. They note that even high-quality PD does not always translate to changed practices. I offer a final example, based in Chile. The research involved revisiting a teacher in the year

following her PD. Whilst this teacher had initially taken on board the PD and integrated it into her classroom programme, when the researchers returned to visit the following year they found she had abandoned the methodology and was engaged in another, contrasting, PD (Gellert, Espinoza, & Barbé, 2013). These authors suggest the wider context of policy and fast-paced reform worked to limit her formation of professional identity. In general, the literature regarding PD which attend to teacher identity, and understand identity using a sociological frame, tend to consider context as highly important in the production of identity and correspondingly the success of the PD. However, these studies do not always look at context in wider terms, examining the multiple layers of context, and thus limits a more complete understanding of the success and sustainability of PD programmes.

A PD Programme in Chile

One professional development (PD) program currently operating in Chile provides an 8-month workshop promoting non-routine, collaborative problem solving in the mathematics class. The pedagogy is more student-centered than typically seen in Chilean classrooms, which is characterised by the teacher dominating and controlling classroom talk (Gellert et al., 2013; Preiss, 2010). The programme promotes students working in groups to solve non-routine mathematics problems and then discussing their results during plenary sessions. The PD follows principles of ‘reform’ mathematics and shares characteristics with other programs internationally (e.g. Koellner, Jacobs, & Borko, 2011). In 2015, this project provided PD to 140 Chilean teachers from grades 1 to 8. Currently the programme is undergoing extensive scaling-up in a variety of locations along the country.

The PD promoted substantial pedagogical change and ultimately aimed to generate a radical and permanent shift in participants’ mathematics teaching. Such a change is not easy (Guskey, 2002) and teachers may experience “identity conflicts” as they expose their work to scrutiny and are required to “modify proven practices” (Avalos & de Los Rios, 2013). Such difficulties are evident in the research evaluating effectiveness of PD (e.g. Desimone, 2009) and other research analysing teacher identity change after PD, such as described above. Post-course evaluations generated positive responses; teachers reported changed attitudes and strong support for the new pedagogy. Participants demonstrated significant changes in their beliefs to be more aligned with ‘reform’ methods (Cerda et al., 2017). However, it is important to uncover whether these teachers continued developing their practice over subsequent years, whether they incorporated new pedagogies more permanently into their regular practices and identity enactments, and what difficulties they may have faced without the continued PD support.

Methods

I invited all teachers who completed the PD project in 2015 to participate in this follow-up study, and 15 teachers volunteered. The participating teachers all taught in either municipal (public) schools or private-subsidized (voucher) schools. They taught populations of mid to low socio-economic status in urban or rural schools.

During 2016, I engaged with teachers in a series of four ‘email interviews’ to elicit narratives about their experiences with mathematics teaching and in particular of enacting the changed pedagogy of the PD. Each email contained approximately five questions to stimulate reflective responses and typically included a question asking specifically about their teaching of problem solving; for example: “Have you taught problem solving this year? Please tell me how it went?” (Email 1), “Can you tell me about your most successful

problem-solving activity this year?” (Email 4). It was hoped the reflective emails would generate narratives through which teachers could construct their own understandings of their experience (Sparks-Langer & Colton, 1991), and also that using emails would allow for greater reflection, giving teachers the time and space to consider their responses, in a way that a regular research interview does not (James, 2015). Some teachers asked to respond to the email questions via telephone or using the *whatsapp* cell-phone application; in these cases, I emailed teachers the questions one week beforehand to allow a similar reflection time.

Other data collected included classroom observations, undertaken primarily to better understand the specific context and therefore aid email data analysis. I also used these observations to generate further personalized questions for each teacher. The final phase of the data collection was an interview and additional observation with ten of the teachers, those who wished to continue with the project, and this took place in May to June of 2017. Darinka Radovic, a Spanish-speaking colleague from Chile accompanied me to these interviews and assisted in subsequent analysis. Questions here focused more specifically on identity enactments and teacher change, and I used the interviews as an opportunity to clarify the themes uncovered in the previous phases of the research.

All interviews were transcribed, and I coded firstly according to broad research objectives. These were: Evidence of change or learning related to PD, constraints and affordances in mathematics teaching including problem solving, and teacher identity performances. These broad topics produced the initial codes, then within each topic all data was re-coded inductively. Following the methods of Braun and Clarke (2012), the codes were collapsed and combined to form themes. At this point, I used the concept of figured worlds to interpret the themes. In picturing the figured world of primary mathematics teaching and learning in Chile I drew upon my own experiences of primary mathematics teaching in New Zealand, which comprises a markedly different figured world.

Contextual constraints

Four main themes regarding constraints and affordances emerged in the teachers’ discourse: students, curriculum, time, and resources. Whilst each of these were described as a constraint in their teaching of mathematics via collaborative problem solving, at other times teachers considered these same aspects to be affordances. This suggests that these aspects are not constraints in themselves, rather it depends upon the specific context and individual views of the teachers and is related to their identities as teachers of mathematics (see Darragh & Radovic, submitted). For the purpose of this paper, I will focus on how these operated as constraints and look at the influence of context on each constraint.

Comments about students dominated teachers’ discourse and, in the majority, teachers spoke about their students as being deficient in some way: they were seen as lacking, academically or intellectually, or lacking group work skills (see also Darragh & Valoyes-Chavez, submitted). Often comments related the problems to the students’ backgrounds - for example pairing a low SES situation with academic issues:

Their socio-cultural level is low, they do not have good reading habits, they are disrespectful and intolerant of each other [...] some fight, twelve children have untreated ADHD, they are rude and have no interest in learning. (Marcela)

The constraint purportedly caused by students emerged very early in the data set. Teachers frequently mentioned students as being one of the difficulties they felt they would

face in the teaching of problem solving and as being a limitation that they face in teaching more generally.

Although the recently updated national curriculum emphasises problem solving (MINEDUC, 2012), teachers spoke more of the enacted curriculum (Remillard, 2005) as developed by the management team in their particular school. In the case of teachers working in voucher schools, these were run by organisations which develop their own curricula (albeit based on the national document) to develop teaching plans and in some cases textbooks. At some grade levels, the teachers must follow highly scripted lesson plans that follow a strict sequence of lessons. Other comments pertained to the curricular constraint generated by national exam called SIMCE¹:

The challenge that comes to me this year is that my class should take the SIMCE and I would like to have the skills to get a good score. (Maob)

The constraints on teaching generated by standardised testing are well documented in the literature (Morgan, Tsatsaroni, & Lerman, 2002; Pausigere & Graven, 2013; Walls, 2008). Within Chile, these tests are high-stakes for the teachers and schools rather than for the students. Students do not ever learn their test scores but those of the schools are published, schools earn bonuses for high marks and this monetary reward is passed on to teachers. Teachers also spoke about their evaluation being connected to test results, despite purporting to be based on the dimensions of quality teaching.

There is a contradiction between what the ‘framework for good teaching’ asks of us, that is, written criteria and ideal descriptors in 4 different areas on which our job performance is evaluated, because when the time comes to say if you're good or bad teacher it is the results of the SIMCE standardized tests which weigh in (María).

Thus, for those teachers who taught a SIMCE year class (annually in 4th, 8th, and biannually in 6th grade for mathematics), there were significant pressures to cover the large quantity of content associated with the test, and to teach problem solving in the style of SIMCE, rather than the ‘non-routine’ version of the PD.

In addition to time needed to prepare for SIMCE tests, teachers referred to the large amount of content they needed to teach within a limited period. Teachers also felt they needed more time outside of the classroom to plan, to reflect and to meet with colleagues.

The conditions [in Chile] are not the best, put in relation to the quantity of class hours and hours to plan – it is the worst. We have many hours in front of the children, without sufficient time to prepare, revise and correct material. I think it is a great debt, in my school I count on more time for planning (Rosario).

The teachers in public schools often brought up lack of resources as a constraint, in particular:

In the public schools, in which I work, they don't provide all the necessary supplies to do our job (paper, photocopying, pens, amongst others). They ask for teaching materials, technology and such is the bureaucracy that they arrive years later, do not arrive, or arrive in insufficient quantities for an entire course. There is no autonomy to manage resources according to the realities of each school (María).

The constraints described above were not the case for all teachers at all times. In fact, within each of the themes the teachers also spoke of affordances. The students were viewed as surprisingly capable, some schools did allocate time specifically for problem solving in the curriculum and the amount of resources available depended on the wealth of the school.

¹ SIMCE is an acronym standing for *System of Measurement for the Quality of Education* in Spanish.

In 2015 after a seven-week strike, public school teachers gained a guaranteed 30% of their working hours set aside for non-contact time. These teachers spoke of the changes as an affordance on their ability to plan for and enact new teaching pedagogies.

However, these contextual constraints were not only evident across a range of teachers, they were also evident as key discourses even in their absence, for example, Javiera's comment suggests sufficient resourcing is certainly not something automatically assumed:

Thanks to God, this school can count on good conditions. When we need any material, the school obtains it. We have various concrete teaching materials with which the children can experience and better visualize geometry. The rooms are good – not too big, they have everything to create a good lesson. (Javiera)

Similarly, the surprise that teachers expressed of their students actually being able to do collaborative problem solving suggests their expectations were actually the opposite. In this manner, even when talking of an affordance to the teaching of mathematics and problem solving, the teachers at times reinforced the notion of these aspects as being constraints.

Storylines in figured worlds

We may gain an understanding of the figured world of teaching primary mathematics in Chile by close attention to the storylines evident in this data. Here I have space to discuss two: a *storyline of deprivation*, and the *neoliberal storyline*.

The storyline of deprivation is evident across a number of the constraints mentioned by the teachers. Schools are deprived of resources, teachers are deprived of time, and students are lacking, both academically and financially, they are deprived of 'quality' backgrounds. This particular storyline is produced by the local context of lower socio-economic status populations. Here, the personal and local contextual layer of students and their family background interacts with the wider political context in which Chile has the greatest gap between rich and poor in the developed world (Bellei & Cabalin, 2013). This disparity is reflected in educational inequality and visible in the large number of schools servicing communities in lower socio-economic levels, a demographic pertaining to the majority of teachers in this study. When working in such a context teachers tend to draw from, and contribute to, these storylines of deprivation (see also Healy & Powell, 2012).

A second storyline evident in the data is a more familiar story worldwide; it is the neoliberal story of testing and performance evaluations. This is a global storyline of performance evaluations of teachers, measured through their students' test results, and influencing curricula. This layer of context operates at the global level, but specifically in Chile, the market-based educational system (Bellei & Cabalin, 2013) was adopted early and completely. Schools are privatised, giving rise to the impact of context at an institutional level - the local interpretation of the curriculum can supersede the official curriculum. Nation-wide policies can be seen as a key influence particularly in the use of nation-wide standardised testing, SIMCE exams. Arguably, the market model of education may also indirectly contribute to the deprivation storyline for those working in schools that lose funding as vouchers follow the students to other schools.

Following Holland and colleagues (1998), figured worlds are a "realm of interpretation" in which characters, such as students, are recognised in particular ways, significance is assigned to certain acts, such as problem solving teaching, and certain outcomes are valued over others, such as SIMCE test results and performance evaluations. The data here demonstrates how students are recognised as lacking and problematic, problem-solving teaching is seen as constrained, and results in SIMCE tests, which ask questions that are shallow versions of problem solving, are valued over rich mathematical tasks. The neoliberal

and deprived storylines are produced in various layers of context and these storylines work against the success and sustainability of the PD.

Contrasting worlds

Reform discourse provides an alternative figured world for mathematics learning and teaching. In this world, the act of non-routine problem solving is valued and strongly endorsed in research literature. The PD provided to the teachers in this study drew from this world, aligning the strategies with tried and true approaches that were developed elsewhere in the world, in countries that shared some contextual aspects yet differed significantly in other ways. A limitation of the PD is that it may not have adequately adapted the project to the world of primary mathematics teaching in Chile; there did not appear to be consideration of typical storylines of deprivation and neoliberal performative education in the delivery of PD.

Secondly, I wish to mention the contrast in the figured worlds of mathematics teaching and learning in New Zealand and Chile. I designed a research project based on assumptions derived from my own origins from a very different figured world. This world did not have lack of space in the classroom; it was well resourced, with students and teachers accustomed to autonomous group work and no nation-wide exam system. I imagined a world where change would be rapid because it was not so very different. The contrasting reality required an adjustment to data analysis. Rather than investigating how teacher identity might change in response to new pedagogies, I was able instead to look at the role of context in the formation and enactment of teacher identity and surmise the crucial role of the culturally produced identity in the success or failure of PD (Darragh & Radovic, submitted).

By way of conclusion, I suggest that the various layers of context influence success and sustainability of PD. It does so firstly by generating real constraints on the act of teaching and learning and secondly by producing storylines which limit the possibilities of change. Specifically, the figured world of primary mathematics teaching in Chile generates storylines that teachers may draw upon and contribute to in citing their difficulties in the enactment of new pedagogies. An attention to all the layers of context is thus crucial in understanding teacher change and working towards success and sustainability of PD.

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